Piscataquog River Stream Crossing Assessment Project Final Report:
Evaluating Aquatic Organism Passage (AOP)

Prepared by:

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&

Southern New Hampshire Planning Commission

With Assistance from:

New Hampshire Geological Survey; NH DES and NH DOT

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Piscataquog River Stream Crossing Assessment Project Final Report

A Partnership between Trout Unlimited and Southern New Hampshire Planning Commission

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Piscataquog River Watershed Culvert Assessment

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Introduction

This report represents a significant effort by staff and trained volunteers of Trout Unlimited (TU) and the Southern New Hampshire Planning Commission (SNHPC) for the purpose of collecting critical information about the condition of existing road stream crossings located within the Piscataquog River watershed.

The Piscataquog River watershed is roughly 217.8 square miles (138,880 acres) in size and includes the following eleven communities: the towns of Deering, Dunbarton, Francestown, Greenfield, Goffstown, Henniker, New Boston, Mont Vernon, Lyndeborough, Weare, and the west end of the City of Manchester.

Within the watershed, a total of 527 road stream crossings were initially identified through aerial photography and GIS mapping (see following map). Many of these identified crossings were verified in the field, while some were found not to exist. The vast majority of the identified crossings consist of a drainage pipe or box culvert which carriers water under a public right of way or a private road. In the watershed there are also dams, arches and bridges including unpaved paths and rocky fords where people and vehicles previously traveled to cross the water.

The primary focus of this project is the existing drainage pipes, culverts, arches and bridges which currently pass water under a public road or public right of way. Because of the importance of these structures to the overall hydraulic balance of the river system, it is important to assess and understand the condition of these structures to determine if they are currently working or not from both a structural and environmental standpoint.

Ultimately, the size, placement and condition of these structures (e.g. is the pipe blocked by debris or other materials, or is there evidence of perched conditions, undercutting, erosion or flooding either upstream or downstream of the crossing) has a direct impact on the flow and passage of water through the structure as well as the potential for storm damage to surrounding property and the public right of way. This

information is also essential in determining the vulnerability of the crossing as well as its impact on the overall connectivity of the river system for wildlife habitat and aquatic organism passage (AOP).

By working together during the spring and summer of 2012, TU and SNHPC staff and volunteers were able to visit over 480 stream crossings within the watershed. TU staff and volunteers conducted the bulk of this field assessment work. A total of 412 stream crossings were assessed using the 2010 New Hampshire Culvert Assessment Protocol (a copy of the survey forms are provided in the Appendix of this report). All crossings not assessed were either inaccessible, located on private lands, or no crossings were found to be present. The New Hampshire Geological Survey (NHGS) will be retaining a contractor next summer (2013) to complete the assessment of the remaining stream crossings in the watershed as part of a comprehensive fluvial geomorphic study of the river.

We wish to thank TU staff and the many volunteers who worked on this project. We also wish to thank the staff of the New Hampshire Geological Survey (NHGS) which helped provide the necessary field assessment training and reviewed the field surveys to ensure the data collected is accurate and consistent for inclusion in this report.

How this Report Can Be Used

This project specifically serves a dual purpose of providing information to aid in identifying, prioritizing and replacing and/or retrofitting stream crossings which are inadequate or undersized and pose a barrier to aquatic organism passage (AOP) and a risk to public and private property.

All eleven communities within the watershed will be able to use the data in this report to evaluate both the structural and environmental conditions associated with the stream crossings – many of which have been identified as impaired or undersized (see following sections on Methodology and Results). Municipal officials, Road Agents and public works/engineering staff specifically will find this report helpful as supporting technical data in seeking funding to justify the removal, replacement or retrofit of inadequate crossings --- thereby reducing the chance of road and culvert wash-outs during extreme storm events. Many of the drainage structures in the watershed were found to be either new or in old, rusting, eroding and/or in collapsing conditions.

Primarily, this report will be helpful to municipal conservation commissions and environmental organizations in identifying critical wildlife habitat needs and developing conservation and restoration projects designed to protect, improve and/or restore critical habitat connectivity within the watershed primarily by opening up large number of stream miles for greater wildlife diversity and productivity. In short, this report will directly benefit:

- municipal road agents, public works department staff and state agencies in prioritizing and seeking funding for future stream crossing and culvert replacement and upgrades;

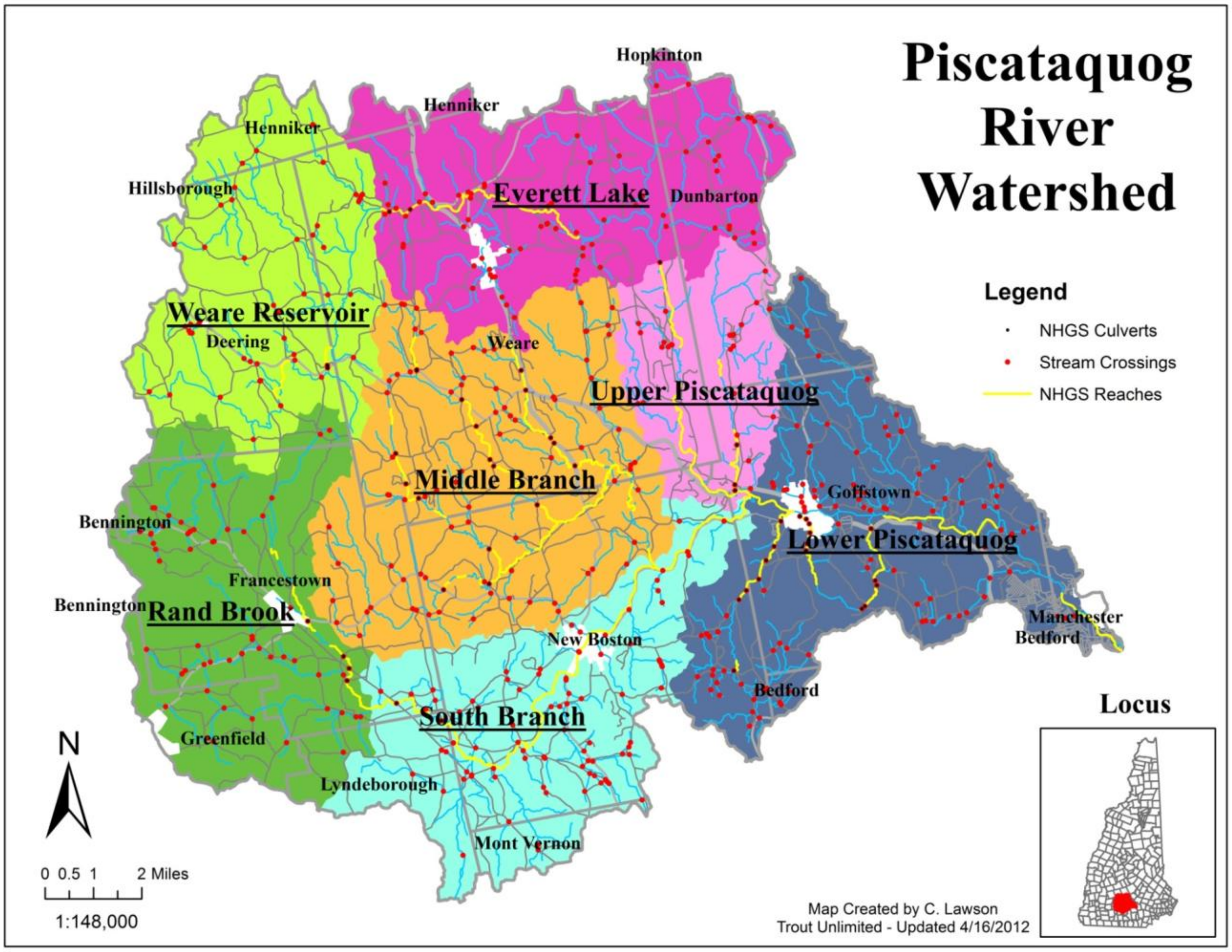
- municipal conservation commissions and environmental organizations in identifying and developing important wildlife habitat connectivity restoration projects for many aquatic organisms, including brook trout;

- NH Geological Survey in conducting a fluvial geomorphic assessment of the river in 2013; and

- Piscataquog River Local Advisory Committee (PRLAC) in implementing an important goal of the updated 2010 Piscataquog River Management Plan which is to restore water quality and protect the natural flow of the river for fish and wildlife habitat and public water uses.

With increasing growth and development and the rise in extreme storm events, many environmental organizations and community residents are seeking information to better understand the environmental impacts to the native brook trout movement throughout the Piscataquog River watershed. By assessing all the road stream crossings, this project has collected the necessary aquatic habitat connectivity data for rating each crossing’s aquatic organism passage to help improve the movement of brook trout through the watershed (the actual field data is contained in the CD attached to this report). In addition, this project builds upon ongoing water quality and aquatic habitat field work compiled by the Piscataquog River Eastern Brook Trout Coalition and will contribute significant data to the upcoming NHGS’s Piscataquog River fluvial geomorphic assessment in 2013.

Map Showing Identified Road Stream Crossings within the Piscataquog River Watershed

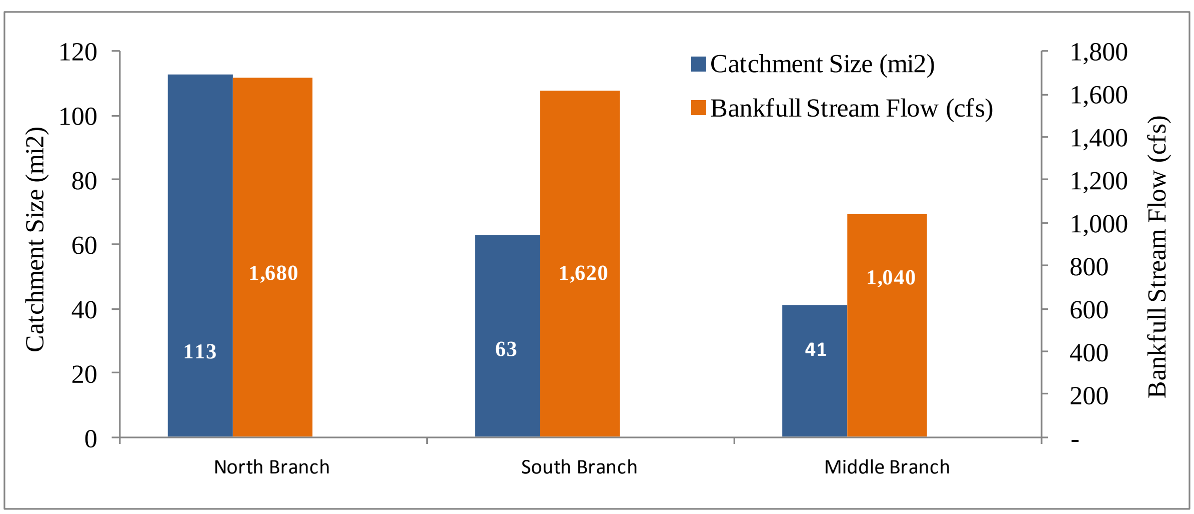


Methodology

The following methodology, results and summary of this project are provided by Colin Lawson, NE Culvert Project Coordinator and Austin Feldbaum, Piscataquog Assessment Project Manager with Trout Unlimited (TU). Both Colin Lawson and Austin Feldbaum coordinated the detailed on-the-ground assessments of the physical condition of each stream crossing throughout the watershed. Field data collection was conducted by a corps of 25 volunteer participants from local TU Chapters (Merrimack River Valley and Basil Woods), the Piscataquog River Local Advisory Committee (PRLAC), community members and graduate students from Antioch University New England. Volunteers were trained on four different days in April 2012 by experienced staff from TU, NHGS, and New Hampshire Fish and Game Department (NHFG).

Data was collected between late April and mid-July 2012. Data input and analysis was conducted between late July and early November 2012. A total of 800 volunteer hours, over 31 work days, were required to field assess all crossings. Another 160 hours completed the data entry and analysis work. Initial assessment was conducted across the entire 217 square mile watershed area; further analysis occurred on the River's three major branches (see Figure 1) and eventually was further delineated into sub-catchments commonly referred to as HUC 12 (Hydrologic Unit Code) scale for easier field work assignments (see HUC 12 basin and grid framework in the Appendix).

Figure 1
Catchment size and bankfull flows on the Piscataquog River's three major branches



Source: Trout Unlimited

Field data collected followed the 2010 New Hampshire Culvert Assessment Protocol, developed by state and federal agency staff as well as multiple regional stakeholder partners (New Hampshire Geological Survey, 2010). This protocol was developed as part of a long-term effort to better understand current conditions of culvert infrastructure throughout New Hampshire. The goal is to identify vulnerable stream crossings posing road safety risks (undersized culverts with a potential to fail during flood events) as well as those creating limited connectivity for AOP.

While the Piscataquog River data was specifically collected to provide information to local decision makers in each community, it is also supporting the growing dataset, managed by NHGS, enabling state agency personnel to better evaluate road stream crossings for emergency response planning. Additionally, latitude and longitude was collected at each site along with six different photographs of each culvert to augment this database.

Once collected, all crossing data was run through an Excel-based computer model, the Culvert Aquatic Organism Passage Screening Tool, which was developed by Milone and MacBroom for the State of Vermont's Rivers Management Program. This tool, adopted by New Hampshire, was designed to quantitatively identify culverts at greatest risk for being potential barriers to AOP (Milone and MacBroom Inc., 2008, 2009). The AOP categories were: 1) **Red**, no passage, 2) **Orange**, no passage except for adult salmonids, 3) **Gray**, reduced passage, and 4) **Green**, full passage. All field data, as well as the AOP ratings, of assessed stream crossings are contained in the CD attached to this report.

Communities are now able to use this information to help prioritize vulnerable culverts for restoration. While the primary concern for some towns might be public road safety issues, results from this AOP assessment are valuable to begin to evaluate undersized stream crossings and to understand current impacts to an extremely valuable community wildlife resource.

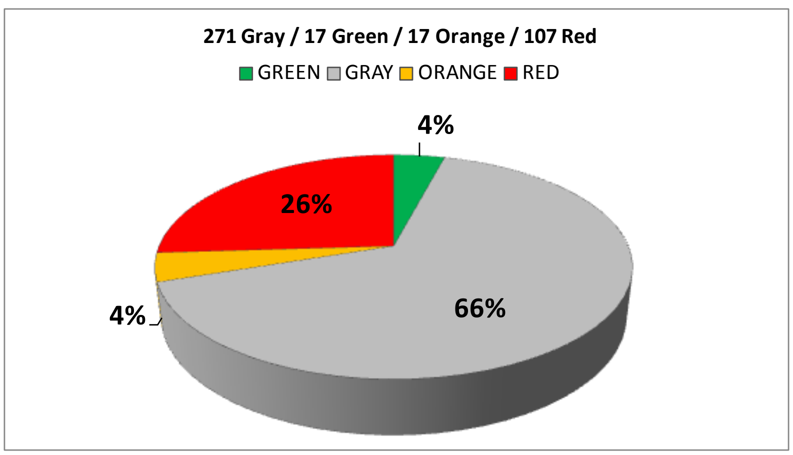
Results

A total of 487 crossings were visited by field volunteers; full assessments were completed on 412 of those sites. Of the crossings surveyed, approximately 75 crossings were not able to be scored for AOP parameters due to issues such as private lands, inaccessible locations, and wetland features up or down stream.

The resulting dataset of 412 crossings was used for the AOP analysis (see Figure 2). Of the 412 sites assessed:

- **66 percent** of crossings surveyed represented reduced connectivity for fish passage depending on flow conditions and life stage;
- **26 percent** were determined to be complete barriers to AOP;
- **4** percent were considered barriers for all but adult salmonids; and
- **4** percent were completely passable by all species.

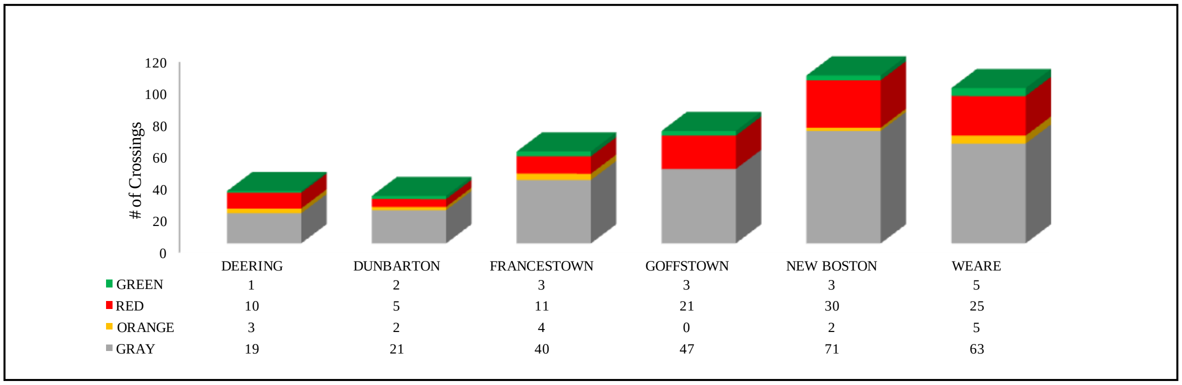
Figure 2
AOP status of all assessed crossings



Source: Trout Unlimited

Greater than 96 percent of all the stream crossings assessed are located in the following six towns identified in Figure 3: Deering, Dunbarton, Francestown, Goffstown, New Boston and Weare. Figure 3 provides a summary of these sites and includes the AOP score rating for each crossing.

Figure 3
AOP status and number of crossings in the six major towns



Source: Trout Unlimited

Of the 412 crossings assessed, 358, or 87 percent were considered culverts. Bridges and arches (crossings with a natural substrate stream bed) both accounted for 27 crossings making up the additional 13 percent (see Table 1). The majority of the culverts assessed were round (318, 89 percent), 11 (3 percent) were concrete box culverts, and 29 (8 percent) were elliptical.

Table 1
Structure type of assessed crossings

Type	# of Crossings	% of Total
Arch	27	7%
Bridge	27	7%
Culvert	358	87%
	412	100%

Source: Trout Unlimited

Concrete and steel were the most common structure materials observed making up 40 percent and 24 percent of the total, respectively (see Table 2). Plastic was another frequently used material and represented 18 percent of the total.

Table 2
Structure material of assessed crossings

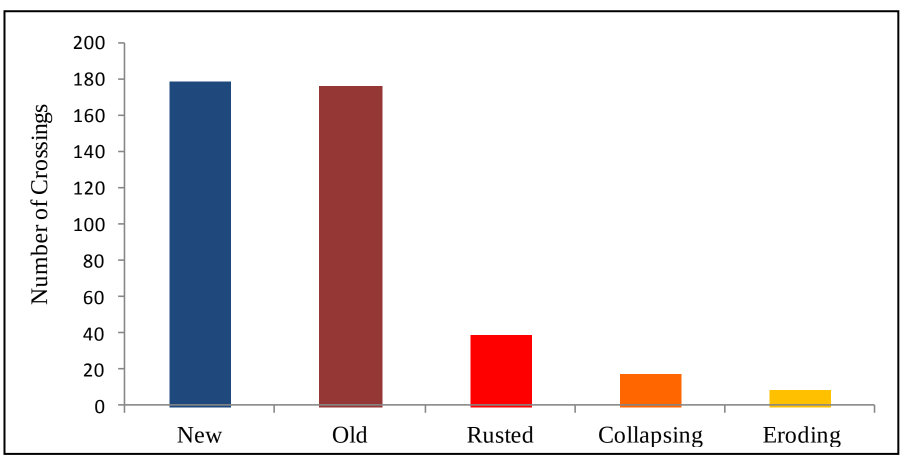
Materials	# of Crossings	% of Total
Concrete	163	40%
Steel	98	24%
Plastic	74	18%
Aluminum	42	10%
Stone	30	7%
Timber	5	1%
	412	100%

Source: Trout Unlimited

Overall, **43** percent of the stream crossings assessed are considered to be: **New** or in relatively good condition; **42** percent of the crossings were found to be in **Old** condition, with the remaining **15** percent falling into **rusted, collapsing or eroded** categories (see Figure 3).

Only **10** percent or 35 of the 412 crossings assessed had streambed substrate material throughout the length of the crossing. Lack of substrate indicates that a structure presents at least a partial barrier for aquatic organism passage.

Figure 3
Condition of all road stream crossings



Source: Trout Unlimited

In this analysis, **28** percent of the crossings were >50 feet in length (see Table 3). The average length of these crossings was 83.5 feet and the median was 63 feet. Published literature references crossing length as a contributing factor to reduced AOP.

Table 3
Length of stream crossing

Length (ft)	# of Crossings	% of Total
< 10	3	1%
10 to 19	15	4%
20 to 29	79	19%
30 to 39	90	22%
40 to 49	108	26%
> 50	117	28%
	412	100%

Source: Trout Unlimited

Of major concern, **34** percent of crossings (free-fall and cascades) were found to have perched outlets, with water cascading or free-falling to the water surface below. For these sites, one foot was the average drop to pool with 0.6 foot the median drop. A perch crossing is considered a contributing factor to reduced AOP.

Table 4
Outlet condition of stream crossings

Condition	# of Crossings	% of Total
At Grade	236	48%
Free Fall	126	26%
Cascade	37	8%
Backwatered	13	3%
	412	85%

Source: Trout Unlimited

Comparing crossing structure width to channel bankfull width, a total of 57 percent of the stream crossings were < 25 percent of stream bankfull width. This indicates that many of the crossings assessed are sized to one quarter or less of the average width of a stream during its typical channel forming flow event; normally the two-year stream flow cycle. In addition, 31 percent were less than 50 percent of channel width. Of concern, only 9 and 2 percent of the total number of crossings were sized for 75 percent or 100 percent respectively of the bankfull width (see Table 5). Current NH stream crossing recommendations suggest all structures be sized for at least 1.2 bankfull widths.

Table 5
Crossing Structure Width as a Percent of Stream Bankfull Channel Width

% Bankfull Width	# of Crossings	% of Total
< 25	178	57%
26 to 50	98	31%
51 to 75	29	9%
> 100	7	2%
	312	100%

Source: Trout Unlimited

Obstructions on the upstream end of culverts, such as wood or sediment, reduce aquatic organism passage. The analysis of these inlets indicates that 41 percent of the crossings surveyed were found to be partially obstructed by wood, sediment or a combination of both (see Table 6).

Table 6
Crossing Structure Obstruction by Materials

Obstructing Material	# of Crossings	% of Total
No Obstruction	236	57%
Wood Only	81	20%
Wood and sediment	50	12%
Sediment Only	36	9%
Deformation of culvert	7	2%
Debris	2	0%
	412	100%

Source: Trout Unlimited

Slope also plays an important role in aquatic organism passage. Results of the slope assessment showed 25 percent of the stream crossings had a slope of greater than 3 percent; published literature reflects crossings with slopes greater than 3 percent begin to negatively impact AOP for juvenile salmonids and 6 percent for adult salmonids (see Table 7).

Table 7
Slope of stream crossing structures by percent categories

Slope (%)	# of Crossings	% of Total
≤ 1	161	42%
2 to 3	134	35%
4 to 6	64	17%
7 to 9	22	6%
≥ 12	6	2%
	387	100%

Source: Trout Unlimited

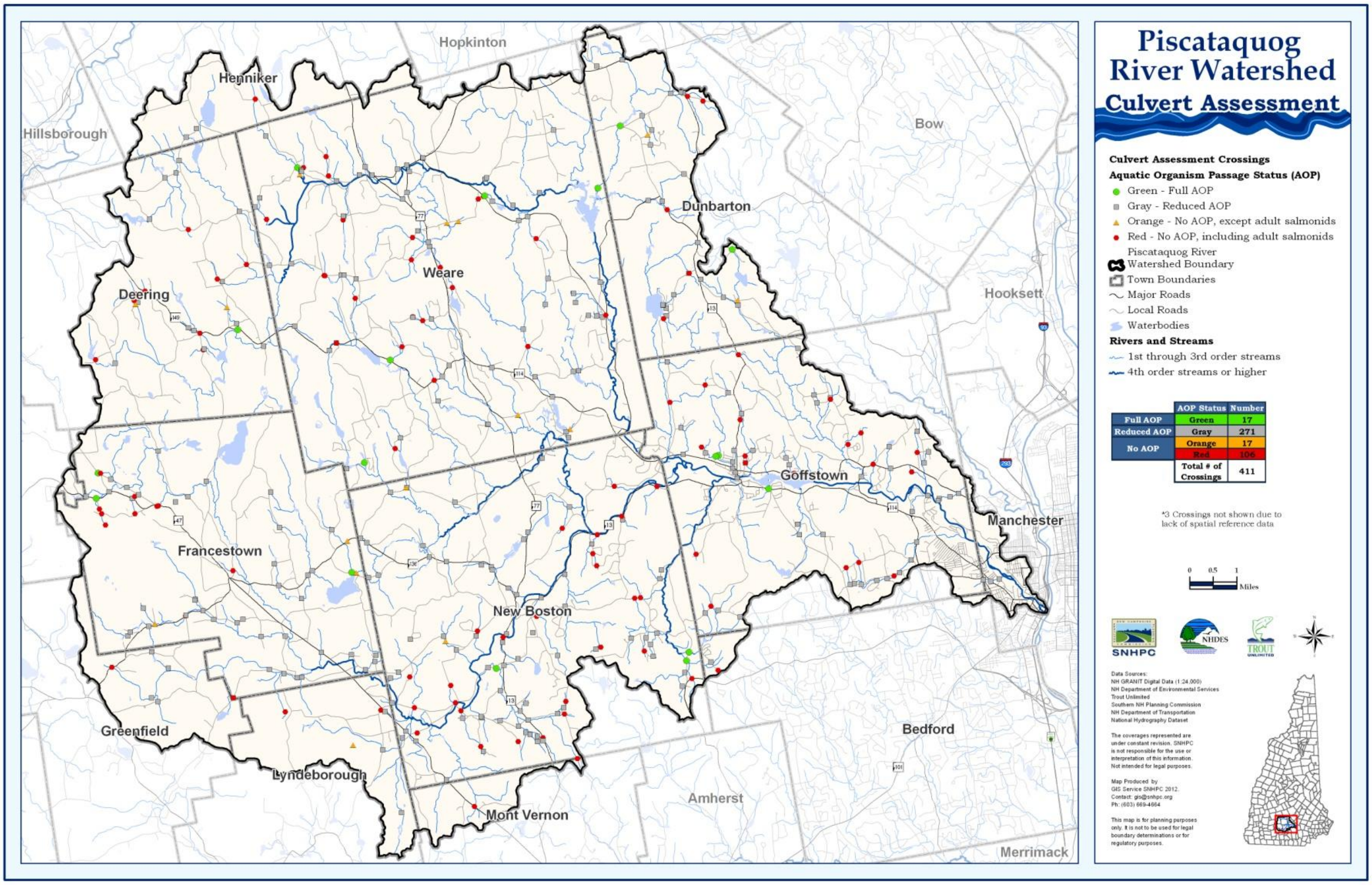
Table 8 is an example of AOP results visually displayed for one tributary in the Rand Brook HUC 12 catchment - Dinsmore Brook. This visual representation allows easy examination of stream crossings negatively impacting AOP for local and regional decision makers.

Table 8
Results of stream crossings on Dinsmore Brook by AOP categories

Dinsmore Brook Crossing ID	Structutre Type	% Bankfull Width	AOP Results
RB_DIBK_02	Culvert	37.7	RED
RB_DIBK_04	Culvert	33.4	RED
RB_DIBK_05	Culvert	29.4	GREEN
RB_DIBK_06	Culvert	34.8	GRAY
RB_DIBK_07	Culvert	52.4	GRAY
RB_DIBK_08	Culvert	28.6	GREEN
RB_DIBK_09	Culvert	27.3	RED
RB_DIBK_11	Culvert	39.7	GRAY
RB_DIBK_12	Culvert	20.2	RED
RB_DIBK_13	Culvert	48.5	GRAY
RB_DIBK_14	Culvert	47.7	RED
RB_DIBK_15	Arch	8.2	GRAY

Source: Trout Unlimited

Watershed Map Showing Stream Crossing AOP Ratings



Discussion of the Results

Some of the stream crossings identified in the initial spatial analysis were not assessed, either because of inability to access these sites or the crossings were nonexistent. All sites are listed, along with field notes, in the completed final database available to community Conservation Commissions and state and federal agencies in both Microsoft Access and Excel formats. In some cases, sites on Class VI roads or private lands may be accessible by foot or off-road vehicle; these additional sites may be completed during the 2013 field season when landowner permission is received to access these locations.

The reader should understand results of this stream crossing assessment have been run through a computer model designed for assessing AOP and should not be viewed as absolute. Further spatial and visual assessment of impassable crossing would provide a more accurate final evaluation rather than purely modeled results. However, this initial gross assessment can be used as a first step in evaluating potential impassable stream crossings that might be viewed as problem sites in an overall evaluation of watershed AOP.

Results of this assessment placed crossings in one of four categories: Green, Gray, Orange, and Red. Culverts categorized as Green are considered to allow full AOP. These crossings represent no known barrier for the movement of fish and amphibians and are likely to pass all aquatic organisms based on the model's algorithms. Gray crossings indicate reduced AOP for certain aquatic species, at different life stages either by channel or crossing conditions or structural deficiencies. Orange crossings indicate no passage except for adult salmonids. Lastly, Red crossings represent no passage by any species. Figure 1 outlined the current AOP condition of all assessed crossings for the Piscataquog River project.

At times, the efficiency of fieldwork was hampered by the difficulty of finding sites on rural and/or unmarked roads. Fortunately, local volunteers' knowledge of the area, combined with use of GIS to distinguish between different class roads, largely enabled field teams to resolve location issues in the field. Additional landmarks such as trails and wetlands on maps helped field crews navigate without cluttering up field maps at 1:25,000 scale. Also, valuable local property and stream information was gained through conversations with landowners and neighbors who occasionally encountered project team members during field assessments. This underscores the importance of outreach and education during the early planning phases of project development. These lessons and others will supply additional insights while planning future assessment projects.

Assessing 85 percent (412) of the entire watershed's road stream crossings was a significant achievement for a community based project. Overall, 107 of these surveyed crossings, or 26 percent, scored as Red, or impassable, for AOP. This figure is not as high as observed in other watershed wide AOP evaluations in NH. However, with the largest portion of crossings, 271 or 66 percent, falling into the Gray category, a significant number of crossings currently have reduced AOP. This figure is difficult to quantify due to the variability of crossings labeled as Gray or "reduced AOP", but it indicates that there are many crossings that still need further analysis to understand specific environmental impacts to the aquatic eco system as well as road stream infrastructure.

As outlined above, 318 or 89 percent of the culverts were round and 29, or 8 percent, were elliptical. The traditional road stream crossings in most towns are round culverts; this is primarily driven by ease of installation and cost. Typical culvert structures can, under most circumstances, be installed by a town's public works department and do not require any sort of sub-structure such as cement footers or abutments. Unfortunately, most culverts were never properly sized to pass the full bankfull stream flows. This flow rate is the "channel forming" volume of water that occurs on average every two years; often referred to as the "2-Year Storm Interval". Undersized culverts often lead to higher erosional forces on both up- and downstream ends of culverts. Larger stream flows frequently push water through the pipes at higher velocities eventually eroding out the downstream channel creating an ever widening and deeper pool. This action finally leads to a perched, and impassable, culvert. This condition is one of the major problems reducing or eliminating AOP.

One advantage to elliptical and box culverts are the opportunity to upsize culvert capacity and to embed these crossings into the stream bed to eliminate the potential to develop perched conditions. Natural substrate in a crossing greatly enhances both AOP, at all life stages, as well as reducing instream velocity of stream flows due to the roughness coefficient. This feature greatly enhances AOP giving migrating fish a chance to rest in naturally forming eddies. Only 10 percent or 35 of the 412 crossings assessed had streambed substrate material throughout the length of the crossing. Lack of substrate indicates that a structure presents at least a partial barrier.

As far as stream crossing materials go, concrete and steel were the most common structure materials observed making up 40 and 24 percent of the total, respectively (Table 2). Concrete structures normally have as slightly longer lifespan than steel but steel is often a stronger structure depending on design and installation techniques. Steel is often easier to install in relation to construction crews handling the structure. Plastic pipes can be less expensive and potentially last far longer; however, often these structures are not as durable and tend to collapse and fail after the same amount of time as other options with shorter lifespans.

Figure 3 illustrates that 43 percent of the crossings were considered to be New or in relatively good condition. This is slightly better than what has been observed in many other watershed assessments. Although the percent of "New" crossings would ideally be much higher, the reality is this is an expensive proposition to undertake and an excellent long-term goal for a community to work toward. The immediate and ongoing challenge for many Piscataquog River communities is the 42 percent of crossings found to be in Old condition, with the remaining 15 percent falling into rusted, collapsing or eroded categories. This failing infrastructure will present a significant financial investment for communities over the next couple of decades. One suggestion is for communities to consider creating a restructuring / replacement schedule based on a combination of assessments and results consisting of this AOP assessment as well as a hydraulic and geomorphic assessment being completed over the next couple seasons.

Culvert length is considered a limiting factor to AOP. The major reason for this is stream flow velocities within the pipe; this inhibits AOP from being able to swim up through the pipe during periods of high flows. With 28 percent of the crossings having an average culvert length > 50 feet, the concern is these longer pipes will prevent any passage for all but the stronger swimming adult salmonids. Another impact of this longer pipe is the increased velocity of stream flows on the downstream end of a crossing. Greater erosion will occur with greater velocities. With 34 percent of crossings having perched outlets, connectivity is greatly reduced. For most species, the median drop of perched crossings from this assessment is 0.6 feet limiting passage to all but adult salmonids.

Natural materials such as wood and sediment are often welcome additions to stream channels, enhancing both habitat cover and spawning substrate. However, at times, they can also become a major impact to AOP. Properly sized structures are designed to facilitate the movement of instream wood and sediments. If culverts are properly installed, these materials would only become potential obstructions during major storm events where materials may get blocked in undersized structures. Table 6 outlines the present condition of culvert inlet obstructions across the watershed. With 57 percent of crossings not having any obstruction, this factor would not necessarily drive the to restore a specific crossing. However, it could be an important reason to upsize a crossing so as to not worry about potential failure due to these materials. Slope also plays an important role in aquatic organism passage. Results of the slope assessment showed 17 percent, or 70 crossings had a slope of greater than 3 percent and 33 crossings were greater than 6 percent; as mentioned, prevailing literature suggests crossings with slopes greater than 3 or 6 percent negatively impact AOP for juvenile and adults salmonids respectively (Table 7).

Summary

By collecting this assessment information, watershed communities will be able to easily evaluate both environmental and potential road hazard risks associated with undersized road stream crossings. Having access to this critical data, municipal road agents and department of public works staff can take advantage of updated information to assist in prioritizing and restoring inadequate and undersized crossings. These actions will not only help to enhance AOP, it will also present a chance to reevaluate community risk associated with culvert failures during extreme storm events. In the end, this proactive approach to addressing infrastructure needs within the watershed will help reduce maintenance and repair costs, safeguard against road safety issues, as well as protect critical environmental habitat associated with stream fragmentation.

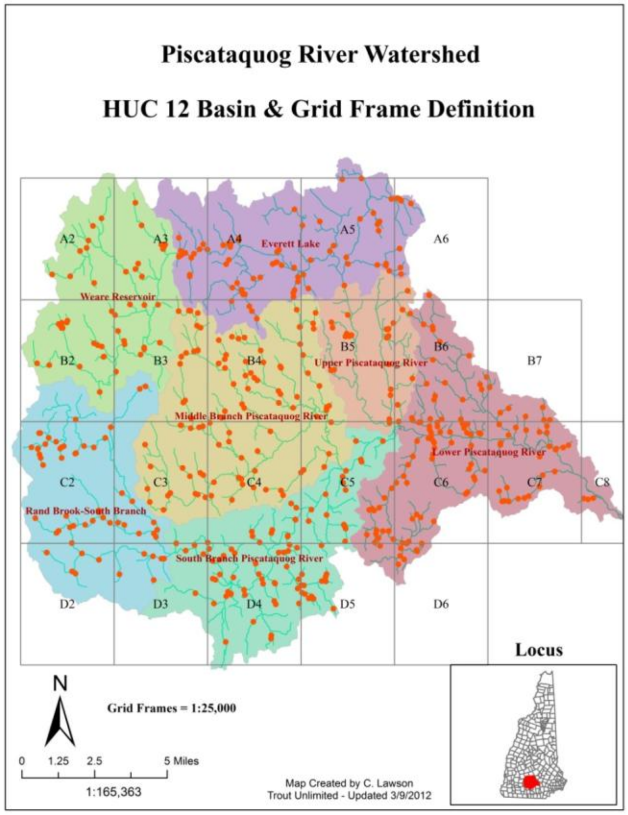
Additionally, this project will assist: (1) municipal conservation commissions in identifying and developing important connectivity habitat restoration projects for brook trout; (2) assist NHFGD and NHDES in prioritizing funding for future restoration projects and other actions designed to protect the river; (3) support NHGS in supplementing the fluvial geomorphic assessment study of the river; and (4) support the Piscataquog River Local Advisory Committee (PRLAC) in implementing an important goal of the updated Piscataquog 2010 River Management Plan which is to restore water quality and to protect the natural flow of the river for fish and wildlife habitat and public water uses. The Piscataquog River watershed is presently a healthy combination of urban and rural landscapes. To maintain water quality for all of the eleven communities, it is important that towns work across political lines to protect this extremely valuable natural resource. Provided below is an example of a road stream crossing that this project would hope would be replaced to improve AOP. The investment and choice of culvert replacement and/or retrofit is ultimately a local and/or state decision.

Before Tropical Storm Irene

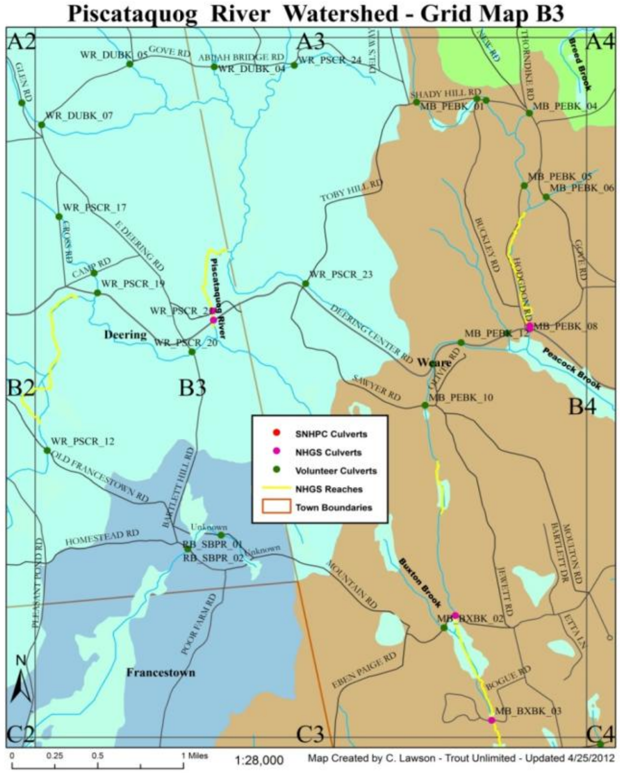
After Tropical Storm Irene

Appendix

HUC 12 Basin and Grid Framework for Field Work
Example Culvert Assessment Protocol Survey Forms
Town Maps Showing AOP Ratings
Field Survey Data and AOP Ratings Provided in Attached CD ROM



Piscataquog River Watershed - Grid Map B3



Culvert Assessment Field Form – Geomorphic & Habitat Parameters

<table>
<tr><td>Structure ID</td><td colspan="3">Unknown ☐</td><td>Structure Number</td><td></td></tr>
<tr><td>Observer(s)/ Organization(s)</td><td colspan="3"></td><td>Date & Time</td><td></td></tr>
<tr><td>Town</td><td></td><td>Datum</td><td></td><td>Latitude (N/S)</td><td></td></tr>
<tr><td>Location</td><td colspan="3"></td><td>Longitude (E/W)</td><td></td></tr>
<tr><td>SGA Reach ID</td><td colspan="3"></td><td>Stream Name</td><td></td></tr>
<tr><td>Road Name</td><td colspan="3"></td><td>Road Type</td><td>paved gravel trail railroad</td></tr>
<tr><td># of shoulder lanes</td><td colspan="3"></td><td>Crossing Condition</td><td>new old eroding collapsing rusted</td></tr>
<tr><td># of travel lanes</td><td></td><td rowspan="3">Structure Materials</td><td rowspan="3">Concrete
Plastic-Corrugated
Plastic-Smooth
Tank
Stone
Steel-Corrugated
Steel-Smooth
Aluminum-Corrugated
Other: ___________</td><td>Structure skewed to roadway</td><td>yes no</td></tr>
<tr><td># of culverts at crossing</td><td></td><td rowspan="2">Flow Conditions</td><td rowspan="2">unusually low typical low
higher than average
flood conditions</td></tr>
<tr><td>Overflow pipe(s)</td><td>yes no</td></tr>
</table>

Geomorphic and Fish Passage Data

General

Floodplain filled by roadway approaches: **entirely** (> ¾ of floodplain) **partially** (¼ – ¾ of floodplain) **not significant**
Structure within ⅓ mile downstream of a significantly steeper segment of stream: **yes no unsure**
Culvert slope as compared with the channel slope is: **higher lower about the same**
Water depth in the crossing matches that of stream: **yes no (significantly deeper) no (significantly shallower)**
Water velocity in crossing matches that of stream: **yes no (significantly faster) no (significantly slower)**

Upstream

Structure opening partially obstructed by (circle all that apply): **wood sediment wood & sediment deformation of culvert none other: _________**

Steep riffle present immediately upstream of structure: **yes no**
If channel avulses, stream will: **cross road follow road cross and follow road unsure**
Estimated distance avulsion would follow road: _______________ **(ft.)**
Angle of stream flow approaching structure: **sharp bend (45° - 90°) mild bend (5° - 45°) naturally straight channelized straight**
Evidence of streambed erosion or aggradation immediately upstream of culvert: **erosion aggradation none**
Culvert inlet: **at grade cascade free fall**
Upstream bankfull widths: 1.)_________ 2.)__________ 3.)_________ 4.)_________ 5.)_________ (ft.)

Reference bankfull widths: 1.)_________ 2.)__________ 3.)_________ 4.)_________ 5.)_________ (ft.)

Downstream

Water depth in culvert (at outlet): _____________ **(0.0 ft.)**
Culvert outlet: **at grade cascade free fall backwatered** _____ **(ft.)** Stepped footers: **yes no**
Outlet drop (invert to water surface): _____________ **(0.0 ft.)**
Pool present immediately downstream of structure: **yes no**
Pool depth at point of streamflow entry: _____________ **(ft.)**
Maximum pool depth: _____________ **(0.0 feet)**
Downstream bank heights are substantially higher than upstream bank heights: **yes no**
Hydraulic control type: **bedrock boulders cobble gravel sand wood other:**_____________
Distance from downstream end of culvert to hydraulic control: ______________ **(ft.)**
Evidence of streambed erosion or aggradation immediately downstream of culvert: **erosion aggradation none**
Downstream bankfull widths: 1.)________ **2.)**_________ **3.)**________ **4.)**________ **5.)**_________ **(ft.)**

	Upstream	Downstream	In Structure	
Dominant bed material (substrate) at structure (use codes below)	**1 2 3 4 5 6 UNK**	**1 2 3 4 5 6 UNK**	**NONE 1 2 3 4 5 6 UNK**	
Bedrock present	**yes no**	**yes no**	Depth of Substrate	**< 1 foot 1-2feet >2 feet UNK N/A**
Sediment Deposit Type	**none delta side point mid-channel**	**none delta side point mid-channel**	**none delta side point mid-channel**	
Elevation of sediment deposits is greater than or equal to ½ bankfull elevation	**yes no**	**yes no**	**yes no**	
			Substrate Throughout? **yes no**	
Beaver dam near structure Distance from structure to dam	**yes no** **distance:** _____ **(ft.)**	**yes no** **distance:** _____ **(ft.)**	**Bed Material Codes** **1 –** bedrock **2 –** boulder **3 –** cobble **4 –** gravel **5 –** sand **6** – silt/clay **UNK -** unknown	
Hard bank armoring	**intact failing none UNK**	**intact failing none UNK**		
Bank erosion	**high low none**	**high low none**		
Stream bank scour causing undermining around/under structure (circle all that apply)	**none culvert footers wing walls**	**none culvert footers wing walls**		

Wildlife Data (left/right bank determined facing downstream)	Upstream		Downstream		**Vegetation Type Codes**
	LEFT	**RIGHT**	**LEFT**	**RIGHT**	
Dominant vegetation type (use codes to the right)					**C –** coniferous forest **D –** deciduous forest **M –** mixed forest **S –** shrub/sapling **H –** herbaceous/grass **B –** bare **R –** road embankment
Does a band of shrub/forest vegetation that is at least 50' wide start within 25' of structure and extend 500' or more up/downstream?	**yes no**	**yes no**	**yes no**	**yes no**	

2

Road-killed wildlife within ¼ mile of structure (circle none or list species)	**species:**		**none**	
Wildlife sign and species observed near (up/downstream) and inside structure (circle none or list species and sign types)	**Outside Structure**		**Inside Structure**	
	species (none)	**sign**	**species (none)**	**sign**

Spatial data collected with GPS: **yes** **no** **Comments/Drawings:**

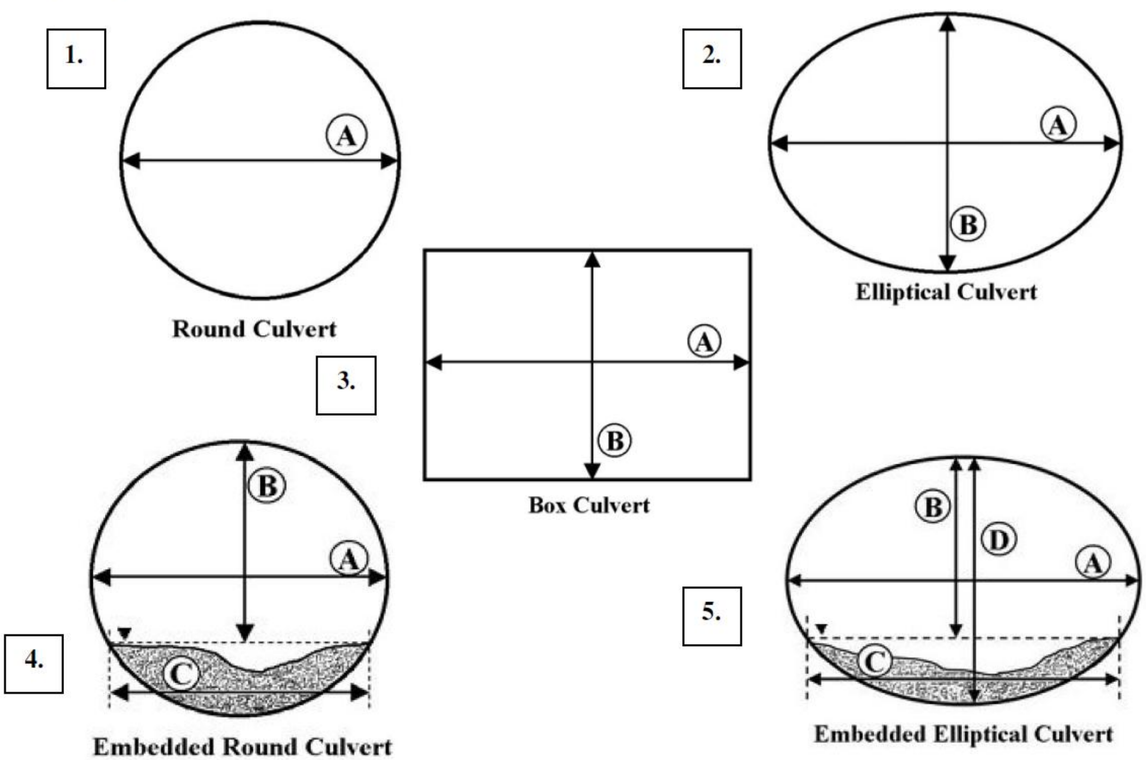
Photos taken: **yes** **no**

Please fill out photo log below

Folder Name:	**Structure Inlet**	**Structure Outlet**	**Above Structure**
Photo View - Upstream	☐	☐	☐
Photo View - Downstream	☐	☐	☐

Record the file name for each photo taken in the appropriate box

Crossing Dimensions



Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐Ford

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): ____________________
Crossing Slope (%):____________________

Note: When inventorying multiple culverts, label left culvert 1 and go in increasing order from left to right from downstream end (outlet) to looking upstream.

Culvert Cell 2 of _______

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5.

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): ____________________
Crossing Slope (%):____________________

Culvert Cell 3 of _______

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5.

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): ____________________
Crossing Slope (%):____________________

Culvert Cell 4 of ________

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5.

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): ____________________
Crossing Slope (%):____________________

<u>Bridge and Arch Assessment Field Form</u> – Geomorphic & Habitat Parameters

Structure type: **bridge / arch**

<table>
<tr><td>Structure ID</td><td colspan="3">Unknown ☐</td><td>Structure Number</td><td></td></tr>
<tr><td>Observer(s)/ Organization(s)</td><td colspan="3"></td><td>Date & Time</td><td></td></tr>
<tr><td>Town</td><td></td><td>Datum</td><td></td><td>Latitude (N/S)</td><td></td></tr>
<tr><td>Location</td><td colspan="3"></td><td>Longitude (E/W)</td><td></td></tr>
<tr><td>SGA Reach ID</td><td colspan="3"></td><td>Stream Name</td><td></td></tr>
<tr><td>Road Name</td><td colspan="3"></td><td>Road Type</td><td>paved gravel trail railroad</td></tr>
<tr><td># of shoulder lanes</td><td colspan="3"></td><td>Crossing Condition</td><td>new old eroding collapsing rusted</td></tr>
<tr><td># of travel lanes</td><td></td><td rowspan="3">Structure Materials</td><td rowspan="3">Aluminum
Concrete
Masonry (arches) & Slabs
Prestressed Concrete/ Post-tensioned
Steel
Timber
Other: ___________</td><td>Structure skewed to roadway</td><td>yes no</td></tr>
<tr><td># of bridge cells or arches at crossing</td><td></td><td rowspan="2">Flow Conditions</td><td rowspan="2">unusually low typical low
higher than average
flood conditions</td></tr>
<tr><td>Overflow pipe(s)</td><td>yes no</td></tr>
</table>

<u>Geomorphic and Fish Passage Data</u>

General

Floodplain filled by roadway approaches: **entirely** (> $^3/_4$ of floodplain) **partially** ($^1/_4$ – ¾ of floodplain) **not significant**
Structure within ⅓ mile downstream of a significantly steeper segment of stream: **yes no unsure**
Water depth in the crossing matches that of stream: **yes no (significantly deeper) no (significantly shallower)**
Water velocity in the crossing matches that of stream: **yes no (significantly faster) no (significantly slower)**

Upstream

Structure opening partially obstructed by (circle all that apply): **wood sediment wood & sediment failure of bridge none other: __________**

Steep riffle present immediately upstream of structure: **yes no**
If channel avulses, stream will: **cross road follow road cross and follow road unsure**
Estimated distance avulsion would follow road: _______________ **(ft.)**
Angle of stream flow approaching structure: **sharp bend (45° - 90°) mild bend (5° - 45°) naturally straight channelized straight**
Evidence of streambed erosion or aggradation immediately upstream of bridge: **erosion aggradation none**
Upstream bankfull widths: 1.)_________ 2.)__________ 3.)_________ 4.)_________ 5.)_________ (ft.)

Reference bankfull widths: 1.)_________ 2.)_________ 3.)_________ 4.)_________ 5.)_________ (ft.)

Downstream

Pool present immediately downstream of structure: **yes no**
Pool depth at point of streamflow entry: ________________**(0.0 feet)**
Maximum pool depth: _____________ **(0.0 feet)**
Downstream bank heights are substantially higher than upstream bank heights: **yes no**
Stepped footers: **yes no**
Hydraulic control type: **bedrock boulders cobble gravel sand wood other:**_____________
Distance from downstream end of bridge/arch to hydraulic control: ______________ **(ft.)**
Evidence of streambed erosion or aggradation immediately downstream of bridge: **erosion aggradation none**
Downstream bankfull widths: 1.)________ 2.)________ 3.)________ 4.)________ 5.)________ (ft.)

	Upstream	Downstream	In Structure
Dominant bed material at structure (use codes below)	**1 2 3 4 5 6 UNK**	**1 2 3 4 5 6 UNK**	**1 2 3 4 5 6 UNK**
Bedrock present	**yes no**	**yes no**	**yes no**
Sediment deposit types (circle all that apply)	**none delta side point mid-channel**	**none delta side point mid-channel**	**none delta side point mid-channel**
Elevation of sediment deposits is greater than or equal to ½ bankfull elevation	**yes no**	**yes no**	**yes no**
Beaver dam near structure Distance from structure to dam	**yes no** **distance: _____ (ft.)**	**yes no** **distance: _____ (ft.)**	**Bed Material Codes** **1 –** bedrock **2 –** boulder **3 –** cobble **4 –** gravel **5 –** sand **6 –** silt/clay **UNK -** unknown
Hard bank armoring	**intact failing none UNK**	**intact failing none UNK**	
Bank erosion	**high low none**	**high low none**	
Stream bank scour causing undermining around/under structure (circle all that apply)	**none abutments footers wing walls**	**none abutments footers wing walls**	

Wildlife Data (left/right bank determined facing downstream)	Upstream		Downstream		
	LEFT	**RIGHT**	**LEFT**	**RIGHT**	
Dominant vegetation type (use codes to the right)					**Vegetation Type Codes** **C –** coniferous forest **D –** deciduous forest **M –** mixed forest **S –** shrub/sapling **H –** herbaceous/grass **B –** bare **R –** road embankment
Does a band of shrub/forest vegetation that is at least 50' wide start within 25' of structure and extend 500' or more up/downstream?	**yes no**	**yes no**	**yes no**	**yes no**	
Road-killed wildlife within ¼ mile of structure (circle none or list species)	**species:**			**none**	

2

Wildlife sign and species observed near (up/downstream) and inside structure (circle none or list species and sign types)	Outside Structure		Inside Structure	
	species (none)	sign	species (none)	sign

Spatial data collected with GPS: **yes** **no** **Comments/Drawings:**

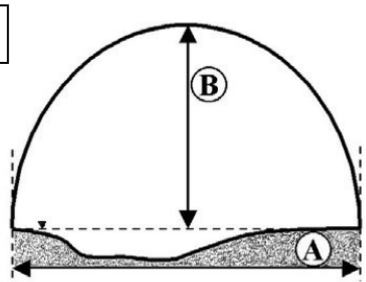
Photos taken: **yes** **no**
Please fill out photo log below

Folder Name:	**Structure Inlet**	**Structure Outlet**	**Above Structure**
Photo View - Upstream	☐	☐	☐
Photo View - Downstream	☐	☐	☐

Record the file name for each photo taken in the appropriate box

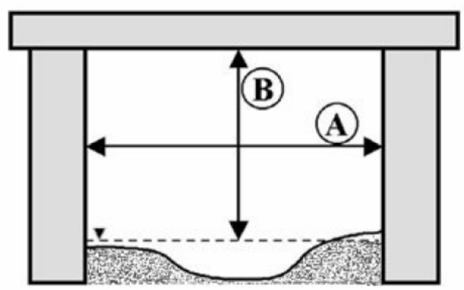
<u>Crossing Dimensions</u>

1.



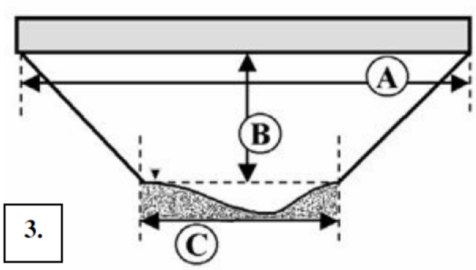
Open Bottom Arch

2.



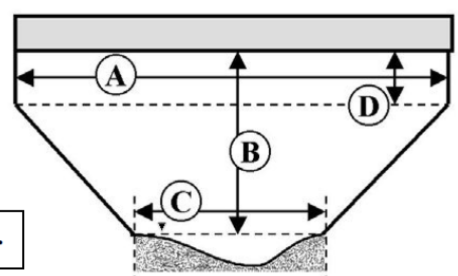
Bridge with Abutments

3.



Bridge with Side Slopes

4.



Bridge w/ Side Slopes & Abutments

3

Crossing Type (from above): ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.** ☐**Ford**

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): ____________________
Crossing Slope (%):____________________

Note: When inventorying multiple culverts, label left culvert 1 and go in increasing order from left to right from downstream end (outlet) to looking upstream.

Bridge/Arch Cell 2 of _______

Crossing Type (from above): ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.**

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): ____________________
Crossing Slope (%):____________________

Bridge/Arch Cell 3 of _______

Crossing Type (from above): ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.**

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): ____________________
Crossing Slope (%):____________________

Bridge/Arch Cell 4 of ________

Crossing Type (from above): ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.**

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): ____________________
Crossing Slope (%):____________________